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PATENT SPECIFICATION

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DRAWINGS ATTACHED

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Int. Cl.:—F 16 h 1/40

COMPLETE SPECIFICATION

Differential Gear Assemblies

We, VAUXHALL MOTORS LIMITED, a British Company, of Kimpton Road, Luton, Bedfordshire, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement: —

This invention relates to differential gear assemblies, primarily for use in motor vehicles.

According to the invention in a differential gear assembly, a pair of bevel pinion gears mesh with a pair of bevel side gears and are carried by a cross pin that is mounted in an opposed pair of slots in a crown wheel forming part of the assembly and the slots are arranged to allow movement of the cross pin along them in a direction substantially parallel to the axis of rotation of the crown wheel. This movement of the cross pin permits self-alignment of the bevel pinion gears.

The cross pin preferably has flat-surfaced or other non-circular end portions arranged to co-operate with the slots to prevent rotary movement of the cross pin about its longitudinal axis.

The bevel pinion gears and the bevel side gears may have part-spherical external surface portions for engagement with a part-spherical internal surface of a casing for the bevel gears. The bevel pinion gears may be free to slide on the cross pin, to allow self-alignment of the bevel gears against the part-spherical internal surface of the casing under the action of gear-engagement reaction forces. The part-spherical internal surface may have been hardened, for example by carbonitriding.

The casing for the bevel gears may be made of pressed steel. Such a construction can be produced accurately in an economical manner, especially when the casing is to have a part-spherical internal surface, no machining to shape being needed. The casing is conveniently a two-part steel pressing the two parts of which are held together by bolts. These bolts may also secure the crown wheel to the casing.

[*Price 4s. 6d.*]

The two parts may have a parting surface generally in a radial plane with respect to the axis of rotation of the crown wheel.

To maintain the two parts of the casing in register, a first of these parts may include an annular dish-shaped portion formed by a radial external flange having its outer periphery turned over to extend axially, this dish-shaped portion having a radial external flange of the second part fitted therein. The radial external flange of the first part of the casing may extend from a generally cylindrical support portion of the first part, with the crown wheel seated in engagement with both the flanges and the support portion.

The cross pin may carry a spacer plate which during operation is held out of contact with the bevel gears, conveniently by the casing for the bevel gears, but during assembly is engageable by the bevel side gears to limit misalignment of these gears, before they are located by the insertion of respective output shafts, for example opposed axle shafts of a motor vehicle. The spacer plate may include terminal scoop portions which extend through respective holes in the casing, for the bevel gears and are arranged to impel lubricating oil into the interior of the casing during operation.

The appended claims define the scope of the invention claimed. The invention and how it can be performed are hereinafter particularly described with reference to the accompanying drawings, in which: —

Figure 1 is a fragmentary section, with some parts in elevation, of one embodiment of a differential gear assembly according to the invention, for use in a motor vehicle;

Figure 2 is a section on the line II—II of Figure 1, in the direction of the arrows; and

Figure 3 is a section on the line III—III of Figure 1, in the direction of the arrows, with some internal parts shown in elevation.

As is shown for example in Figure 1, a differential gear assembly includes a pair of

bevel pinion gears 10 and 12 which mesh with a pair of opposed bevel side gears 14 and 16 keyed to respective ones of a pair of oppositely extending axle shafts 18 and 20 forming output shafts of the differential gear assembly, for driving a pair of driven wheels (not shown) of a motor vehicle.

The bevel gears 10, 12, 14 and 16 are contained within a sheet-steel casing 22 which is generally spherical in shape. The casing comprises first and second parts 24 and 26 held together by bolts 28 which pass through holes in respective radial external flanges 30 and 32 of the parts into corresponding screw-threaded holes in a crown wheel 34, so securing the crown wheel to the casing.

The crown wheel 34 is arranged to be driven by a conventional input pinion (not shown), whereby the crown wheel and the casing 22 rotate as a unit in bearings (not shown) within a conventional axle housing (also not shown) containing lubricating oil.

The first part 24 of the casing 22 includes an annular dish-shaped portion formed by the radial external flange 30, which has its outer periphery 36 bent over to extend axially: the radial external flange 32 of the second part of the casing fits into the dish-shaped portion of the first part to maintain the two parts of the casing accurately in register. The radial external flange 32 of the second part 26 extends outwardly from a generally cylindrical support portion 38 (Figure 3) and the crown wheel 34 is held accurately in register with the casing by being seated in engagement with both the flange 32 and the support portion 38.

The bevel pinion gears 10 and 12 are carried by a cross pin 40 which is mounted directly on the crown wheel 34. The cross pin has reduced-diameter end portions 42 and 44 which are accommodated in respective slots 46 and 48, formed at the inner periphery of the annular crown wheel in a broaching operation used to form the central aperture of the crown wheel. As is shown in Figure 2, the reduced-diameter end portions 42 and 44 of the cross pin 40 have flat surfaces 50 which prevent rotary movement of the cross pin about its longitudinal axis.

The bevel pinion gears 10 and 12 are mounted freely on the cross pin 40. These gears, and the bevel side gears 14 and 16, have part-spherical external surface portions 52 for engagement with a part-spherical internal surface 54 of the casing 22, this surface 54 having been hardened by carbonitriding. The end portions 42 and 44 of the cross pin 40 are free to move along the slots 46 and 48, to allow the cross pin to move in a plane common to the axis of rotation III—III of the crown wheel and the longitudinal axis II—II of the cross pin, namely in the plane of the paper in Figure 1. In this way, self-alignment of the bevel gears can occur during operation, with the part-spherical external surface portions 52 of the bevel gears being biased towards the hardened part-spherical internal surface 54 of the casing under the action of gear-engagement reaction forces. This self-alignment characteristic gives equal distribution of the loads on the meshing teeth of the bevel gears, so increasing the potential load capacity of the bevel gears without the need to produce the assembly to very close tolerances.

As is shown for example in Figure 2, to facilitate assembly and assist lubrication, a generally H-shaped spacer plate 56 is carried by the cross pin 40. The spacer plate includes terminal scoop portions 58 and 60 which extend through respective holes 62 and 64 in the casing and, during rotation in the direction of the arrows 66, impel oil into the interior of the casing, to ensure adequate lubrication of the bevel gears. Movement of the spacer plate along the cross pin is limited by engagement of the plate with the casing, and so the spacer plate is held out of contact with the bevel gears during operation. However, during assembly, the spacer plate limits misalignment of the bevel side gears which could otherwise occur before insertion of the axle shafts.

The differential gear assembly which has been described is thus economical to manufacture, and has a self-aligning characteristic which gives the bevel gears a relatively high potential load capacity. Also, the drive torque of the crown wheel is transmitted directly to the cross pin carrying the bevel pinion gears, rather than by way of a bolted connection.

WHAT WE CLAIM IS:—

1. A differential gear assembly in which a pair of bevel pinion gears mesh with a pair of bevel side gears and are carried by a cross pin that is mounted in an opposed pair of slots in a crown wheel forming part of the assembly, and in which the slots are arranged to allow movement of the cross pin along them in a direction substantially parallel to the axis of rotation of the crown wheel.

2. A differential gear assembly according to Claim 1, wherein the cross pin has non-circular end portions arranged to co-operate with the slots to prevent rotary movement of the cross pin about its longitudinal axis.

3. A differential gear assembly according to claim 1 or 2 wherein the bevel gears have part-spherical external surface portions for engagement with a part-spherical internal surface of a casing for the bevel gears.

4. A differential gear assembly according to claim 3, wherein the bevel pinion gears are free to slide on the cross pin.

5. A differential gear assembly according to claim 3 or 4, wherein the casing for the bevel gear is made of pressed steel, with the part-spherical internal surface hardened.

6. A differential gear assembly according to claim 5, wherein the pressed steel casing for

the bevel gears is in two parts held together by bolts.

7. A differential gear assembly according to claim 6, wherein the bolts also secure the crown wheel to the casing.

8. A differential gear assembly according to claim 6 or 7 wherein the two parts of the casing have a parting surface generally in a radial plane with respect to the axis of rotation of the crown wheel.

9. A differential gear assembly according to any one of claims 6 to 8, wherein a first of the two parts of the casing includes an annular dish-shaped portion formed by a radial external flange having its outer periphery turned over to extend axially, and a radial external flange of the second part of the casing is fitted in the annular dish-shaped portion.

10. A differential gear assembly according to claim 11, wherein the radial external flange of the second part of the casing extends from a generally cylindrical support portion of the second part, with the crown wheel seated in engagement with both the flange and the support portion.

11. A differential gear assembly according to any one of claims 1 to 10, wherein the cross pin carries a spacer plate which during operation is held out of contact with the bevel gears but during assembly is engageable by the bevel side gears to limit misalignment of these gears.

12. A differential gear assembly according to claim 11, wherein the spacer plate is, during operation, held out of contact with the bevel gears by the casing for the bevel gears.

13. A differential gear assembly according to claim 11 or 12, wherein the spacer plate includes terminal scoop portions which extend through respective holes in the casing for the bevel gears and are arranged to impel lubrication oil into the interior of the casing during operation.

14. A differential gear assembly substantially as hereinbefore particularly described and as shown in the accompanying drawings.

15. A motor vehicle in which a differential gear assembly according to any one of claims 1 to 13 has its bevel side gears connected to drive respective ones of a pair of opposed axle shafts for a pair of driven wheels of the vehicle.

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Chartered Patent Agent.

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FIG.1.

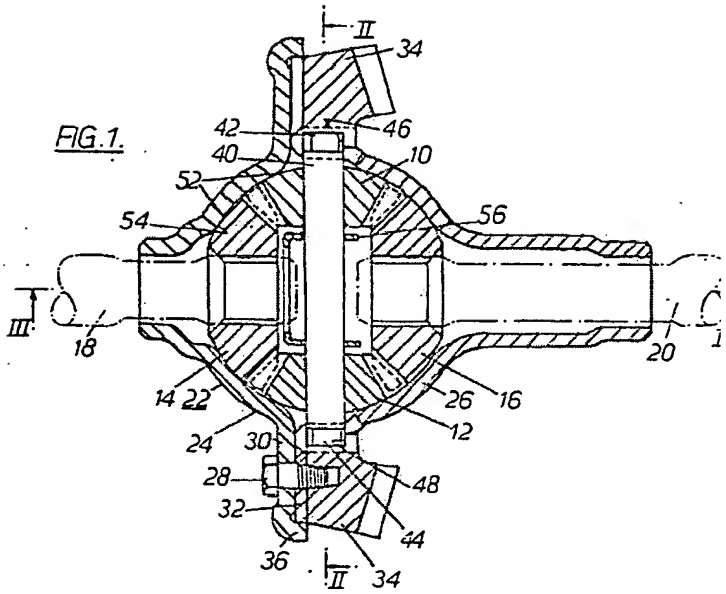
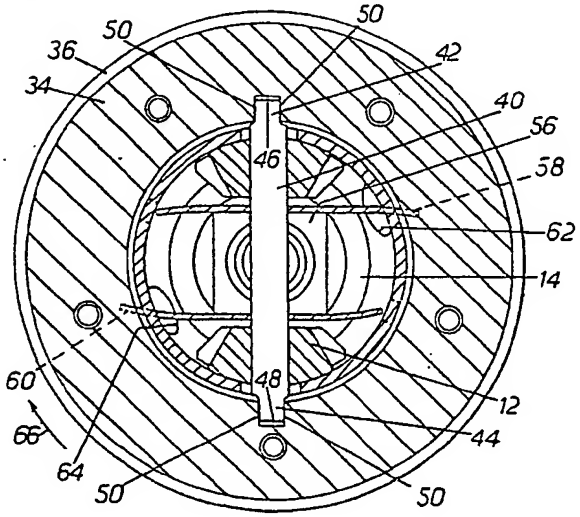


FIG.2.



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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 1 & 2

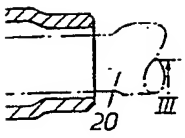
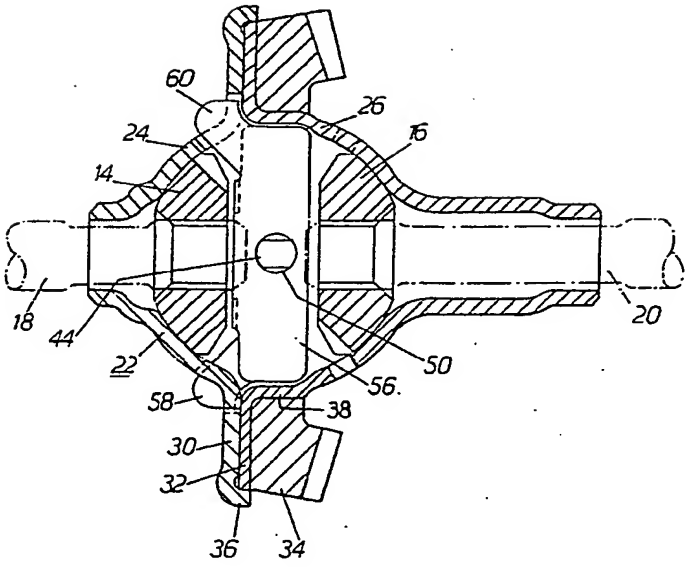
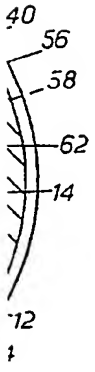


FIG.3.





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Sheets 1 & 2

FIG.1.

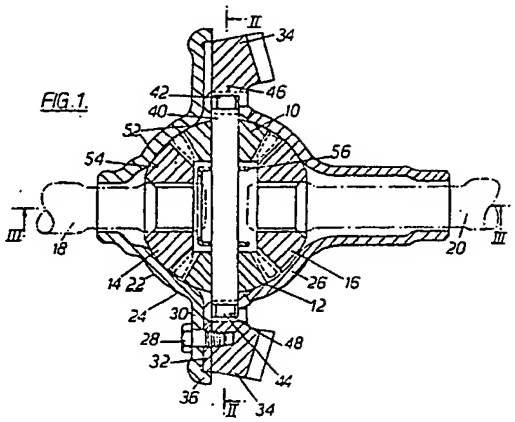

FIG.2.

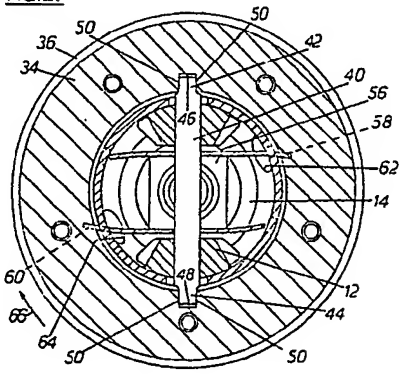

FIG.3.